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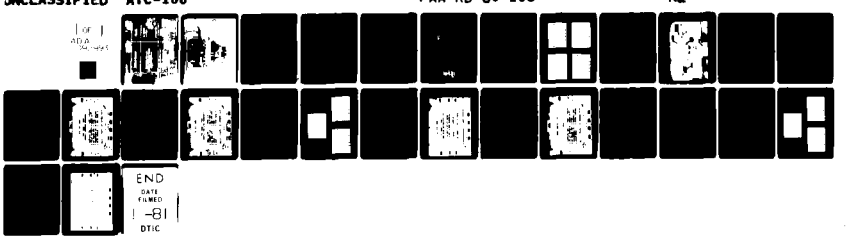
THE DABS DATA LINK AIRBORNE INTELLIGENT DISPLAY OPERATOR'S MANU--ETC(U)
SEP 80 J C ANDERSON, J L LEEPER DOT-FA72WAI-261
UNCLASSIFIED ATC-100 FAA-RD-80-106 NL



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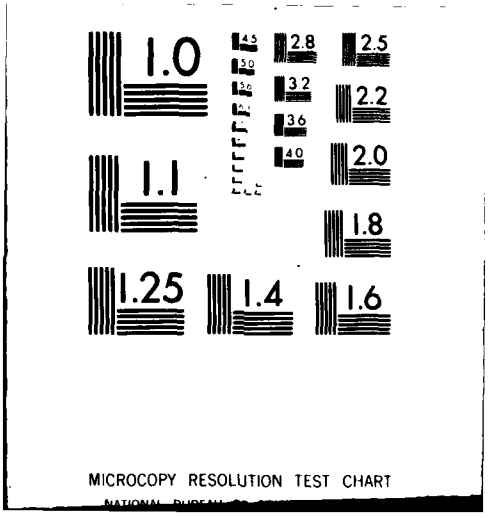
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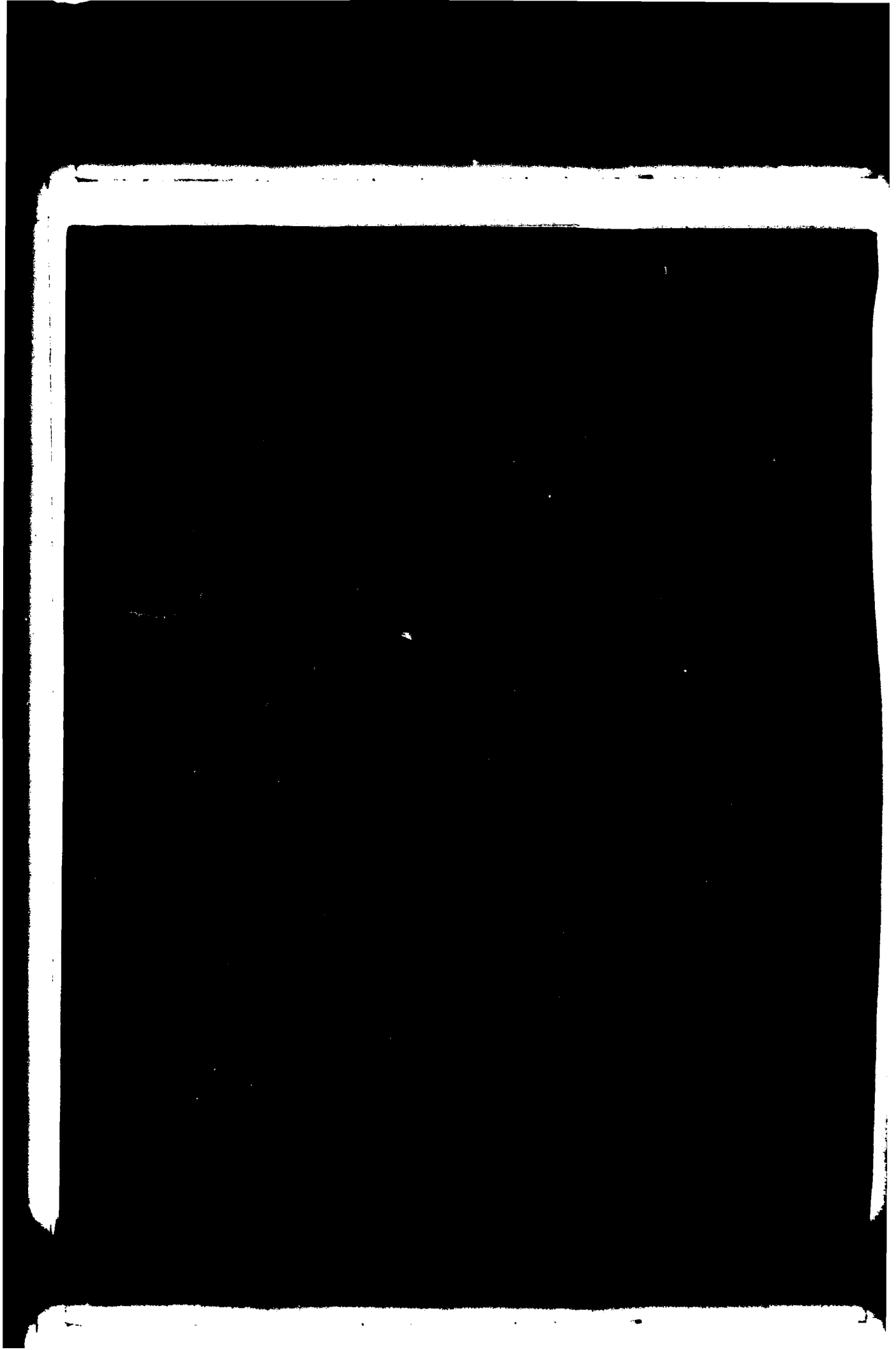

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16. Abstract

The Federal Aviation Administration is currently evaluating the Discrete Address Beacon System (DABS) which will provide increased air traffic safety in current and future air traffic conditions. In addition to improved surveillance accuracy and reliability, DABS provides a two-way data link between the DABS sensor and all DABS transponder equipped aircraft in view. A DABS data link avionics system, called the Airborne Intelligent Display (AID), was developed by M.I.T. Lincoln Laboratory for the purpose of evaluating and demonstrating initial and future data link applications. The microprocessor-based AID system communicates with the DABS ground sensor through the DABS transponder onboard the aircraft. Data link information included in uplink interrogations to the transponder is decoded in the airborne microprocessor and then made available to the pilot on a high visibility cathode ray tube display.

The purpose of this report is to describe the operation and use of the AID.

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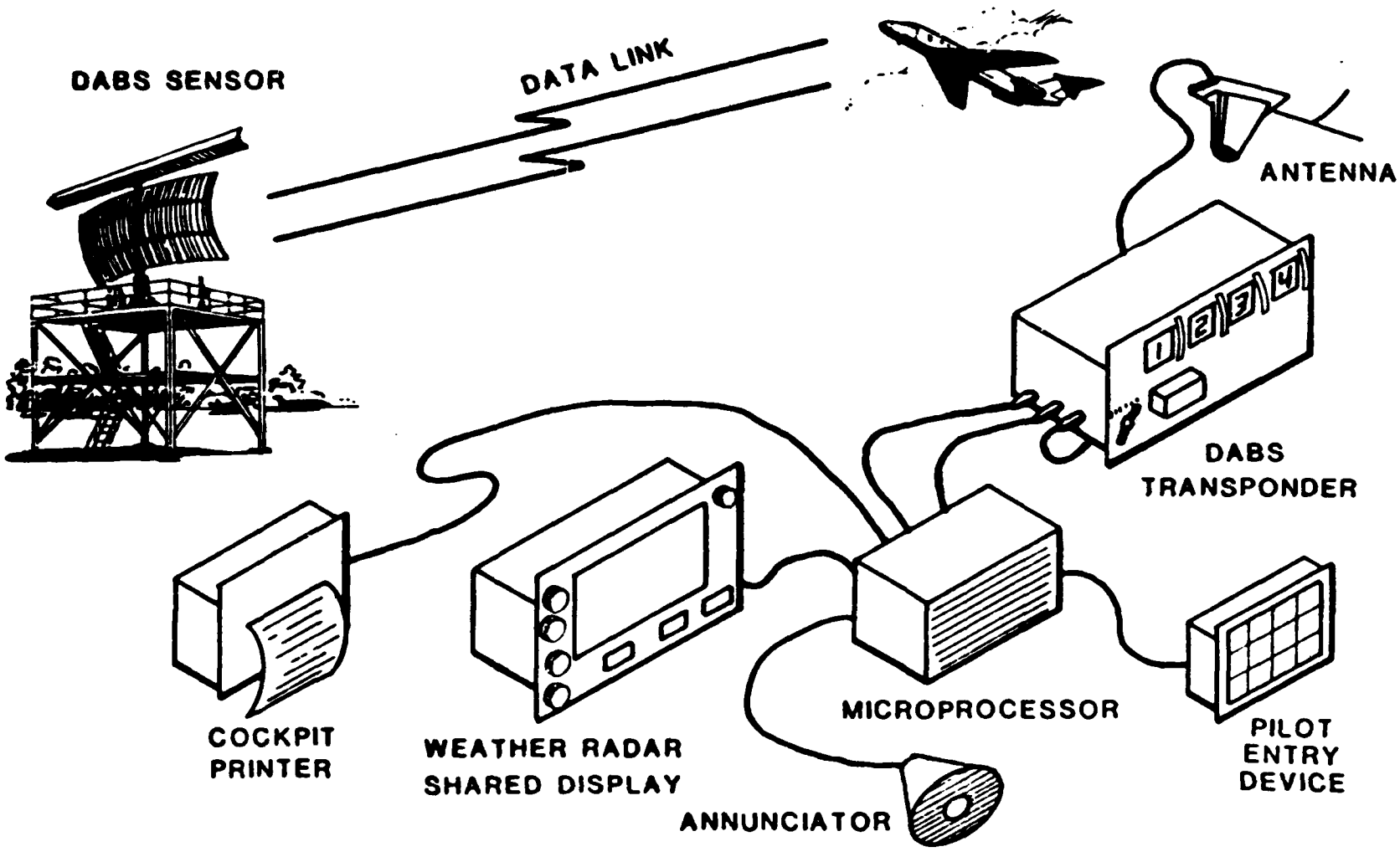
INTRODUCTION

The Federal Aviation Administration is currently developing the Discrete Address Beacon System (DABS) to provide increased air traffic safety in future air traffic environments. In addition to improved surveillance accuracy and reliability, DABS provides a two-way data link between the DABS sensor and all DABS transponder equipped aircraft in view. A DABS data link avionics system, called the Airborne Intelligent Display (AID), has been developed for the purpose of evaluating and demonstrating data link applications.

The purpose of this document is to describe the operation and use of the AID.

AIRBORNE INTELLIGENT DISPLAY SYSTEM



AIRBORNE INTELLIGENT DISPLAY OVERVIEW

The Airborne Intelligent Display (AID) was developed by M.I.T. Lincoln Laboratory to demonstrate and evaluate use of the DABS data link for transmitting aviation-related messages. The microprocessor-based AID system communicates with the DABS ground sensor through the DABS transponder onboard the aircraft. Data link information included in uplink interrogations to the transponder is decoded in the airborne microprocessor and then presented to the pilot on a high visibility CRT (Cathode Ray Tube) display.

The CRT display is a slightly modified color weather radar indicator capable of producing red, yellow, green, blue, magenta, aqua, and white characters and graphics symbols (Fig. A). The character size used for the data link information allows thirteen 32-character lines to be displayed (Fig. B). Characters can be used to present semi-graphic information (Fig. C), or characters can be mixed with the 256 x 256 dot resolution graphics (Fig. D). A future modification will permit the AID to convert the semi-graphics display into a color coded presentation. Note that a single CRT unit can be used to display DABS data link information as well as weather radar data from an onboard radar system.

An annunciator system capable of speech output is used to alert the pilot that messages have been received by the AID. The AID microprocessor includes a prestored vocabulary of approximately twelve words which are used to construct verbal messages such as "TAKEOFF CLEARANCE", "LOW ALTITUDE ALERT" and "MESSAGE PENDING".

Pilot information requests to be downlinked are entered via a calculator-type alphanumeric keyboard using items selected from a menu. Special function keys allow the pilot to edit data, send data to a printer, clear the display, etc. The keyboard is small and light-weight so that it can be mounted on the yoke, or on the cockpit control panel. Tone outputs are included in the annunciator system to provide an audible feedback of acceptance or rejection of all keyboard entries.

A cockpit printer is used to obtain a listing of the alphanumeric and semi-graphics information shown on the display. This reduces pilot workload by preserving information for future reference.

All discussion concerning messages (priorities, display areas used, etc.) are specialized to those associated with the initial set of data link services. Future defined messages will be handled in an appropriate manner using similar rules.

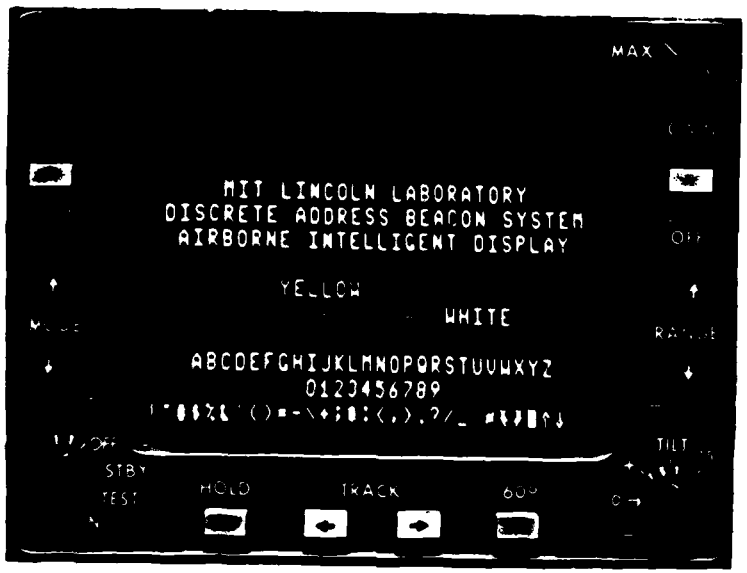


FIG. A. AID COLORS AND CHARACTERS

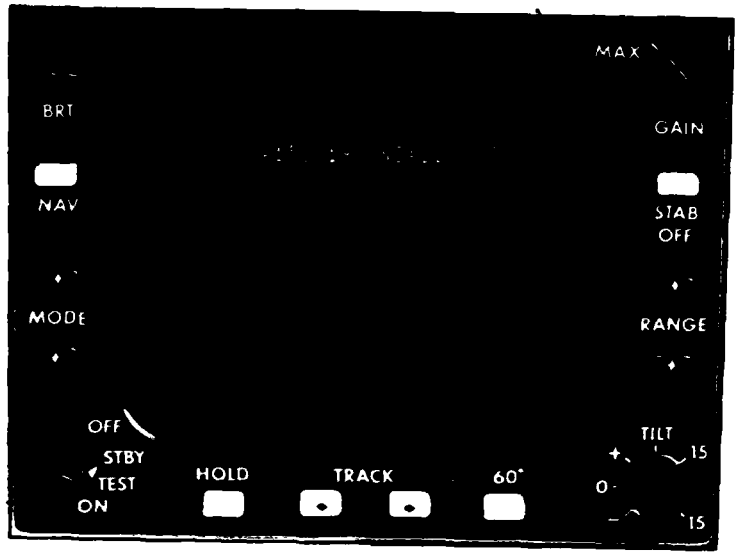


FIG. B. SAMPLE TEXT DISPLAY

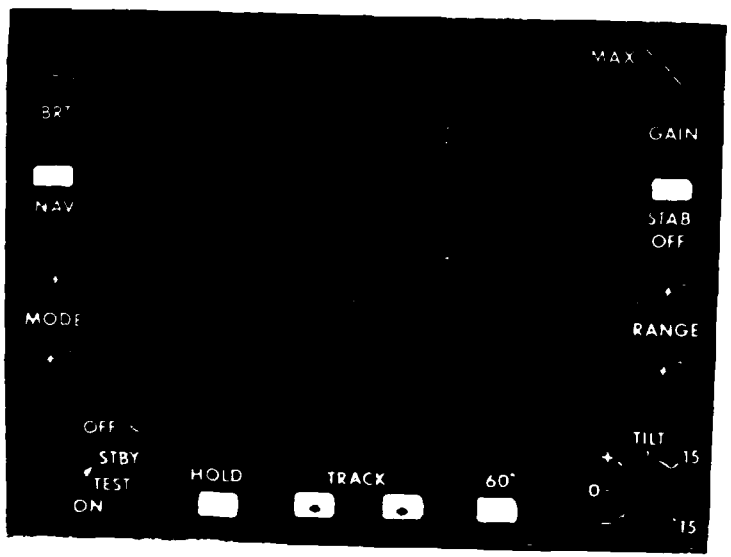


FIG. C. SEMI-GRAPHICS WEATHER MAP

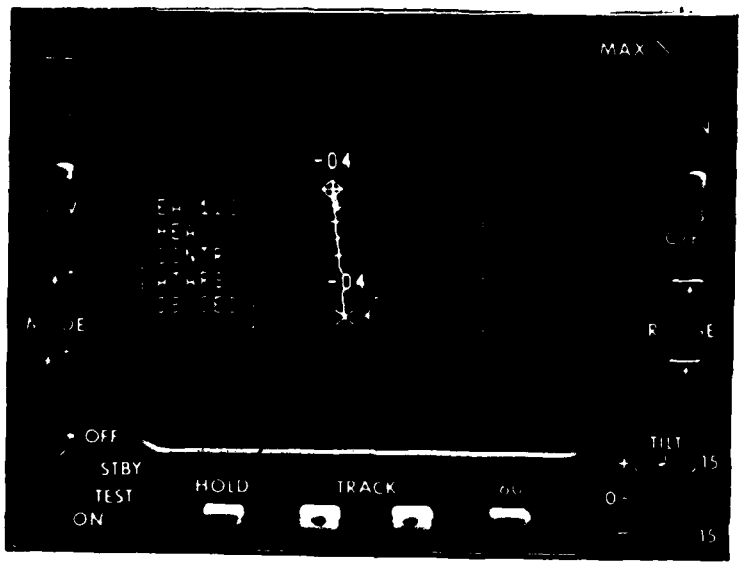


FIG. D. GRAPHICS DISPLAY EXAMPLE

DISPLAY MODES

The CRT display has four display modes, which are controlled by a separate mode select switch in the cockpit. These modes are labeled WX RADAR ONLY, DATA LINK, WX RADAR / DATA LINK, and TEST. The following description assumes that the aircraft is equipped with a complete onboard weather radar system unless otherwise noted.*

WX RADAR ONLY

In this position, power to the data link microprocessor is turned off and the onboard weather radar system and DABS transponder operate conventionally. Turning the mode select switch to this position from the DATA LINK mode resets the data link system and clears all previous messages from memory. If the aircraft is not equipped with weather radar, then this mode turns off power to the CRT display.

DATA LINK

In the DATA LINK mode, the CRT display functions as a display device for various data link messages. Onboard weather radar information is not displayed in this mode.

WX RADAR / DATA LINK

The WX RADAR / DATA LINK mode allows shared use of the display between the onboard weather radar and the data link system. If a low priority data link message is received by the AID, the words MESSAGE PENDING will appear on the CRT and overwrite, but not interfere with, the onboard weather radar data. If a high priority message is uplinked, the data link system automatically disables the weather radar inputs to the CRT and takes over the CRT to display the urgent data link information. Aside from these differences, operation in this mode is identical to the DATA LINK mode.

TEST

The TEST position permits the operator to verify the decoding and display operation of the data link system by introducing sample messages into the system. The top of the display indicates AID TEST MODE when the system is in this mode. Onboard weather radar information is also displayed in this mode, but the AID's interface with the DABS transponder is disabled.

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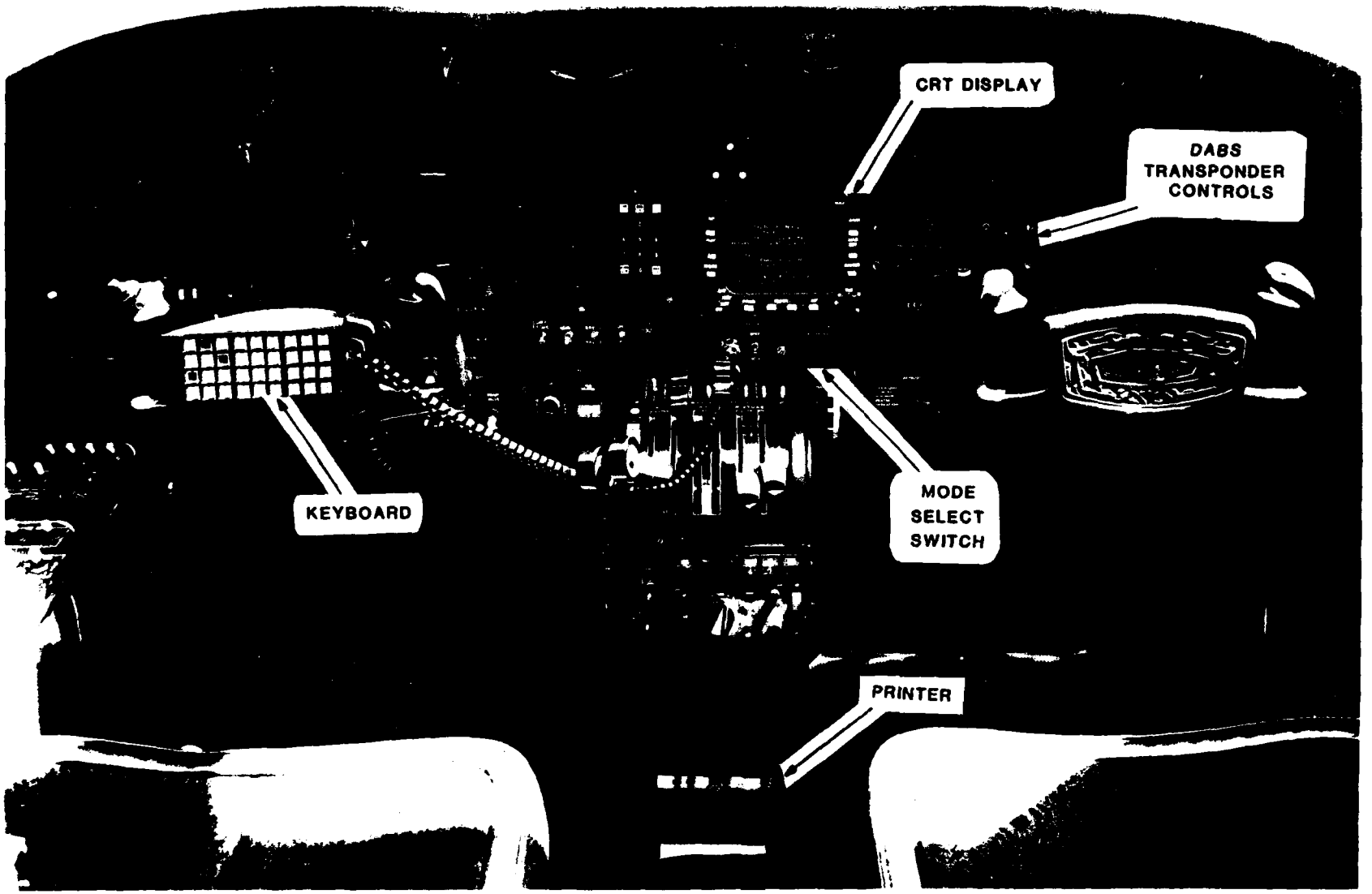
*The onboard weather radar system consists of a CRT display, Transmit/Receive Unit, and antenna. The weather radar operation is controlled from the switches on the CRT display. Even though weather radar information is not displayed in certain modes, the Transmit/Receive Unit will continue to radiate microwave energy . For this reason, the OFF/STBY/TEST/ON switch on the lower left-hand side of the CRT display should not be turned to the ON position unless the aircraft is airborne.

AID COCKPIT EQUIPMENT



DATA LINK DISPLAY PRIORITIES

When used to display data link information, the CRT provides two functionally independent display areas, one occupying three lines and the other ten lines of the thirteen line display area. The top three lines of the display are reserved for ground-initiated "tactical" messages of an urgent nature. The bottom ten lines of the display, called the "general" display area, are used for pilot initiated messages, prompting for keyboard entries, and ATARS (Automatic Traffic Advisory and Resolution Service) messages.

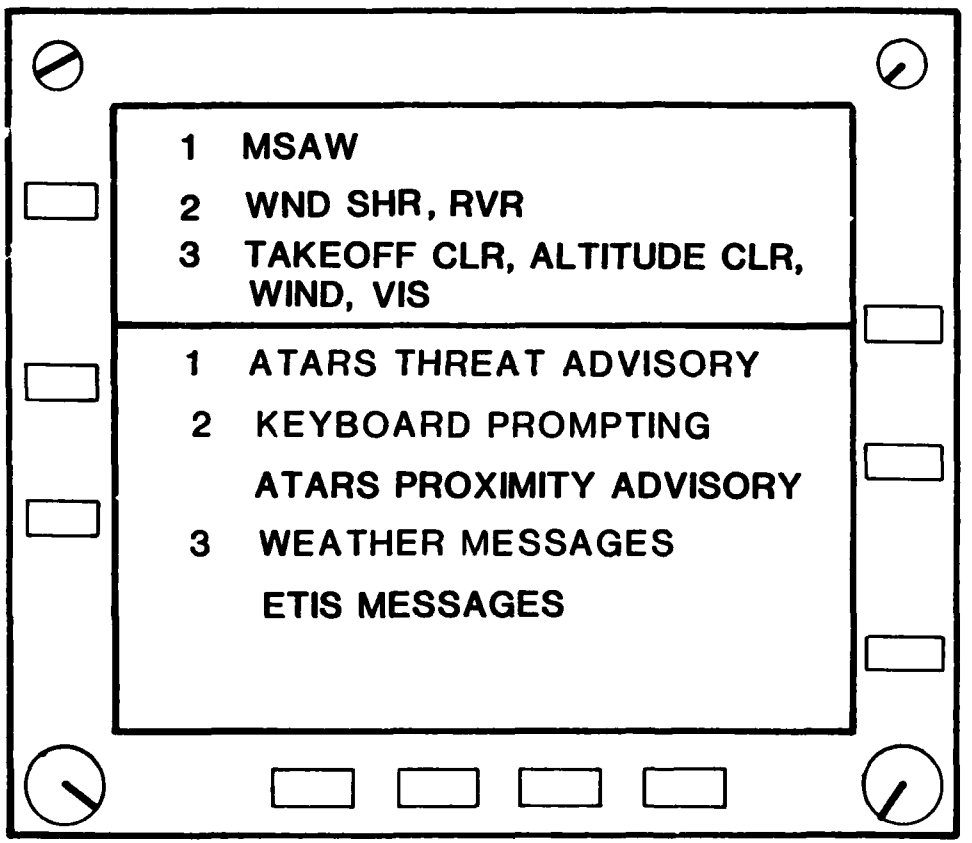
When the CRT is functioning as a data link display device, a priority scheme exists to determine which of several contending messages is to be displayed. The highest priority tactical message type is the Minimum Safe Altitude Warning (MSAW). Wind Shear Alerts (WND SHR) and Runway Visual Range (RVR) have the second highest priority in the tactical area. Takeoff Clearance (TAKEOFF CLR), Altitude Clearance (ALTITUDE CLR), Wind Advisories (WIND), and Visibility Advisories (VIS) all have the lowest priority in the tactical area.

When a tactical message is received by the AID, it preempts any lower-priority message which might have been displayed in the tactical message area. The preempted message is not lost, but is placed in a "stack", or queue of messages waiting to be written in the tactical area of the display. Up to ten such messages can be saved in this stack. Tactical messages of the same priority level are displayed in the order in which they are received.

A similar priority scheme is employed for the general display area, and a separate stack is used to save up to ten messages. If the tactical message area is not being used, but there are items waiting to be displayed in the general display area, then the tactical area is used to indicate to the pilot the number of general messages waiting.

The highest priority item in the general message area is an ATARS threat advisory. The pilot's alphanumeric keyboard entries and ATARS proximity advisories share priority level two. Pilot-requested weather messages and ETIS (Enhanced Terminal Information System) reports are priority three items. When the WX RADAR / DATA LINK mode of operation is selected, the onboard weather radar display is treated as a general display area priority-level-three item.

DISPLAY MESSAGE PRIORITIES



AID TEST MODE - PAGE 1

The AID test mode allows users to become familiar with display operation and the message types included in the initial set of data link applications. In this mode, simulated displays are generated which show examples of what the ground might send to the pilot during actual airborne operation. Onboard weather radar data can be displayed if desired, but actual data link message inputs are disabled in this mode.

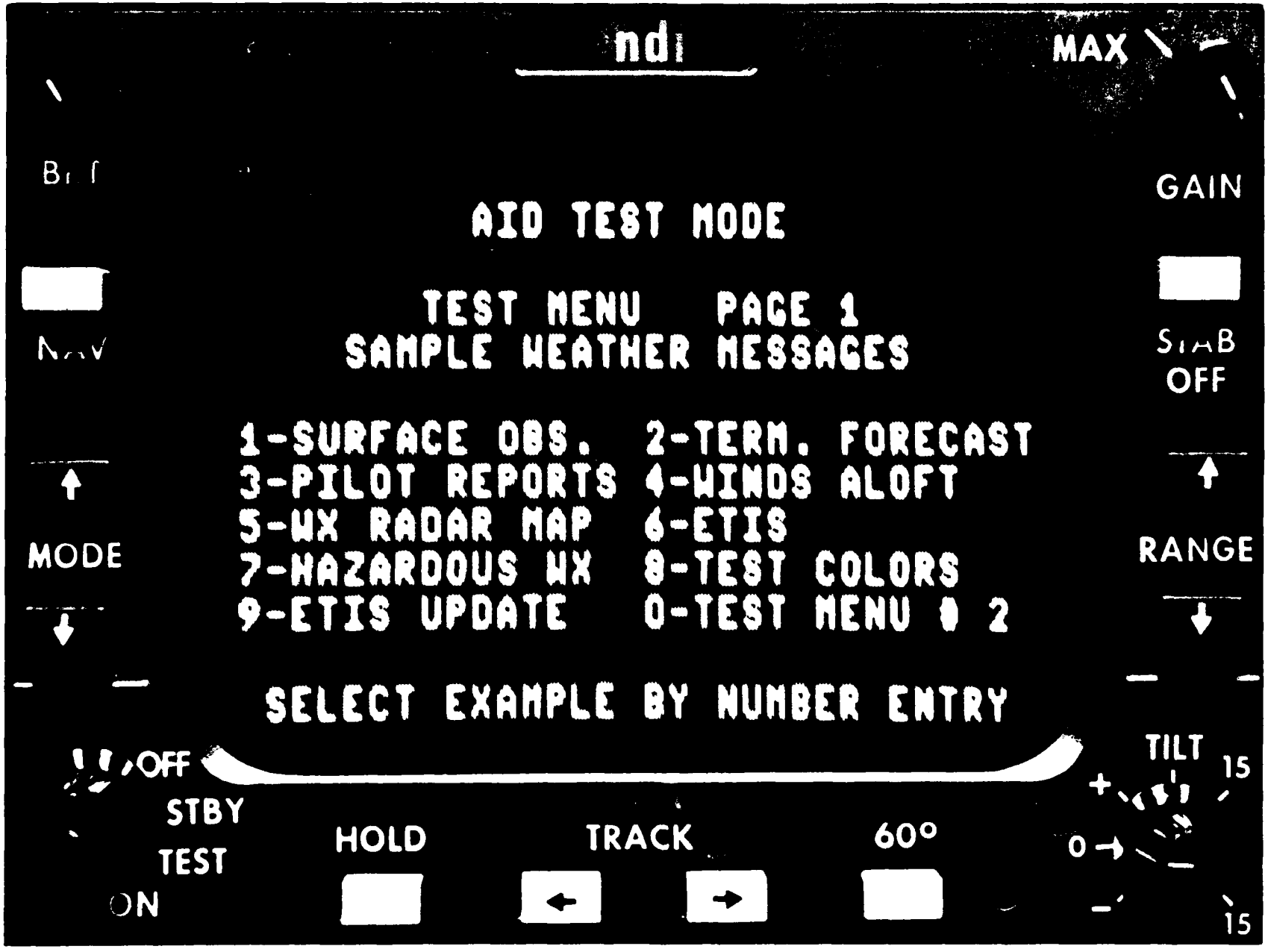
To initiate the AID test mode, the mode-select switch and the switch at the lower left-hand side of the CRT are turned to the TEST position (this inhibits radar emission). The system will display the words AID TEST MODE at the top of the screen, and a weather radar test pattern is also displayed.

A particular test message can now be selected from a "menu" of available test messages. The test menu is organized into PAGEs. PAGE 1 of the menu (displayed by pushing the MENU button on the keyboard) contains text message selections such as requested weather information.

When PAGE 1 of the test menu is displayed (as shown in the figure), the listed messages are recalled by pushing the appropriate number key on the keyboard and are cleared by pushing the CLR DISP button. Items 1 through 7 correspond to the weather products included in the initial data link applications. Item 8 is a test message which illustrates the colors and alphanumeric characters of the AID. The ETIS UPDATE in Item 9 is a typical update message to a general ETIS report. After a single selected menu item has been viewed and then cleared, the display reverts to the weather radar test pattern with AID TEST MODE superimposed. At this point further items can be selected from PAGE 1 by pressing the MENU button as before.

The message stack for the general display area can be used to save a specified sequence of several items for display. For example, if PAGE 1 Item 5, WX RADAR MAP, is currently being displayed and the "8" button on the keyboard is pushed in an attempt to call up another display, the words MESSAGE PENDING will appear in the display's tactical area and a verbal "message pending" annunciation is provided. If more than one message is pending, the superimposed message in the tactical area will change to indicate the number of messages which are waiting to be displayed and the system will reannunciate. When the stack becomes full, subsequent test messages will be discarded.

Pushing the CLR DISP button clears the general display area and forces the next pending message onto the display for viewing. In this example, PAGE 1, Item 8, TEST COLORS, will appear because the "8" button was pushed previously. The ability to queue data link messages in this fashion is a useful feature during airborne operation, as it allows the pilot to view long messages at a convenient time without loss of information. Any alphanumeric information can be saved for future viewing simply by pushing the PRNT button to obtain a listing.

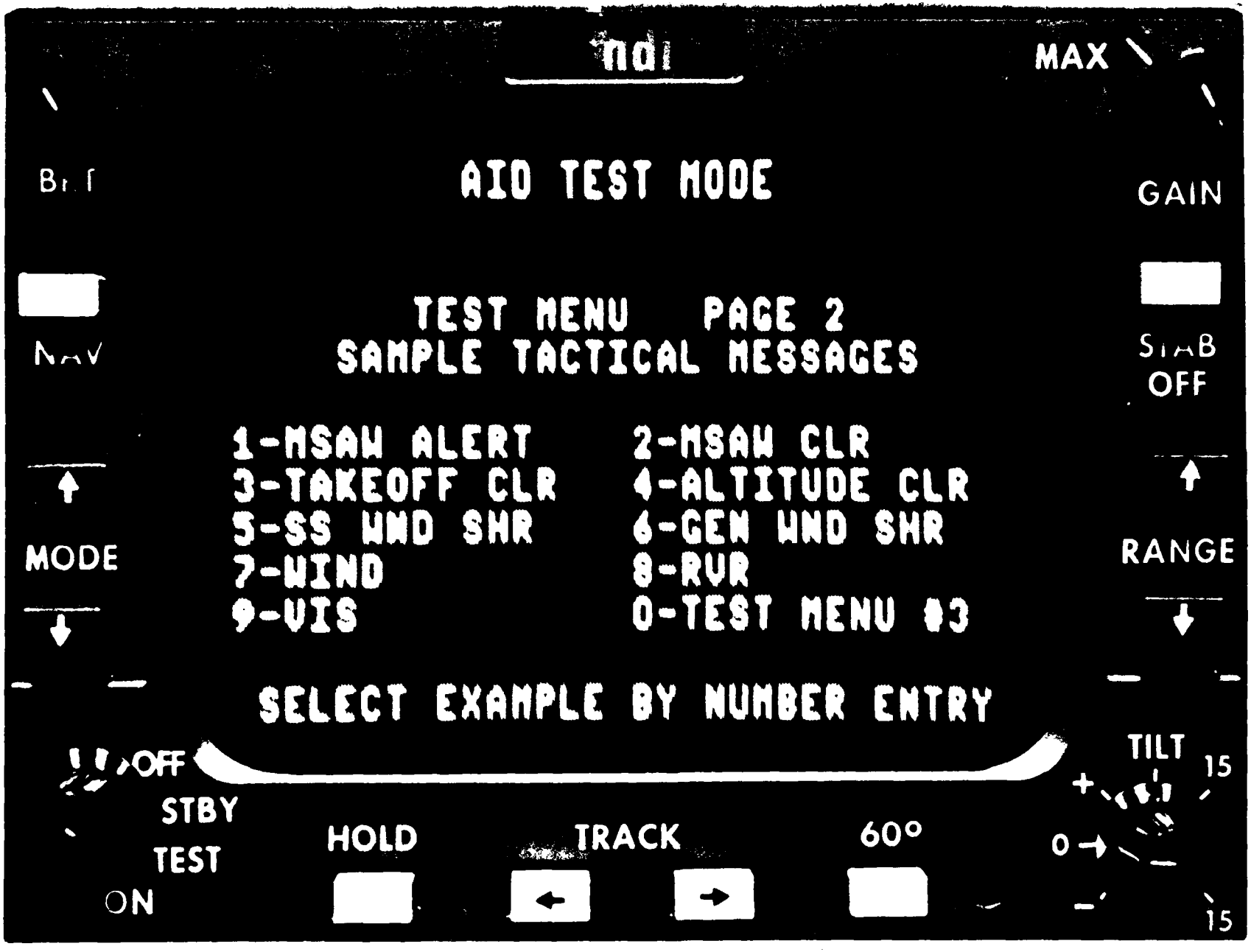

ndi
MAX
GAIN
AID TEST MODE
TEST MENU PAGE 1
SAMPLE WEATHER MESSAGES
1-SURFACE OBS. 2-TERM. FORECAST
3-PILOT REPORTS 4-WINDS ALOFT
5-WX RADAR MAP 6-ETIS
7-HAZARDOUS WX 8-TEST COLORS
9-ETIS UPDATE 0-TEST MENU 1 2
STAB
OFF
MODE
RANGE
SELECT EXAMPLE BY NUMBER ENTRY
OFF
STBY
TEST
ON
HOLD
TRACK
60°
TILT
15
0
15

AID TEST MODE - PAGE 2

Tactical messages can be recalled from PAGE 2 of the test menu (PAGE 2 is called from PAGE 1 by depressing the "0" key), and follow the priority scheme described earlier. When these items first appear in the tactical message area, they are accompanied by an appropriate annunciation and will flash on the display. If no pilot action is taken, these messages will automatically be cleared. In some instances the annunciated message is repeated periodically. If the pilot acknowledges receipt of the message by pushing a YES or NO button on the keyboard, the message stops flashing and will be cleared from the display in five seconds. These messages cannot be cleared by the CLR DISP button.

The first four items on PAGE 2 of the test menu are ATC-related messages, and Items five through nine are messages associated with ETIS final approach information. Final approach information provides the pilot with wind and visibility information as conditions warrant.

An example of a test message which can be displayed in the tactical area is the Minimum Safe Altitude Warning (MSAW) alert. MSAW messages are delivered to DABS data link equipped aircraft when the aircraft is projected to violate low altitude criteria. The MSAW Alert (Item 1) includes the minimum safe altitude value shown at the top of the figure and is delivered to the aircraft each scan as long as the MSAW alert is active. When the MSAW alert is discontinued, an MSAW CLR message (Item 2) is delivered to the aircraft to clear the alert from the cockpit display. In the event that the CLR MSAW message is not received by the aircraft, the display system clears the message if it has not been updated in the previous 15 seconds. A verbal message of "LOW ALTITUDE ALERT" is issued by the annunciator when the original MSAW alert is received or when the safe altitude value changes. The annunciator will repeat the alert every 15 seconds unless the operator has acknowledged the message by pushing the YES or NO button on the keyboard.


MAX
BRT
AID TEST MODE
GAIN
NAV
TEST MENU PAGE 2
SAMPLE TACTICAL MESSAGES
STAB
OFF
1-MSAW ALERT
2-MSAW CLR
3-TAKEOFF CLR
4-ALTITUDE CLR
5-SS WND SHR
6-GEN WND SHR
7-WIND
8-RVR
9-VIS
0-TEST MENU #3
MODE
RANGE
SELECT EXAMPLE BY NUMBER ENTRY
OFF
STBY
TEST
ON
HOLD
TRACK
60°
TILT
15
0
15

TEST DISPLAY EXAMPLES

Figures A, B, and C show further examples of pre-stored displays which can be recalled in the AID test mode. These examples include selections from PAGE 1 (in the general display area) as well as PAGE 2 (in the tactical message area), thus demonstrating the simultaneous display of multiple messages. The system will also display multiple data link messages in the general display area if there is sufficient room, as shown in Figures A and B.

Figure C presents terminal forecast (TERM. FORECAST) information in the general display area, while a WIND and RVR advisory appears in the tactical message area. When wind shear conditions are detected in the terminal area the wind information is replaced by wind shear alert messages. The wind shear alert message can be a general wind shear alert (GEN WND SHR) or a single sensor wind shear (SS WND SHR) alert message. The single sensor wind shear alert includes the wind direction and speed at the centerfield sensor and at a boundary sensor which is identified by direction. A single sensor wind shear alert message, with a surface observation (SURFACE OBS.) and a hazardous weather (HAZARDOUS WX) report was shown previously (Figure B under AID overview).

A takeoff clearance confirmation message (TAKEOFF CLR) is shown with a pilot report (PILOT REPORTS) and winds aloft (WINDS ALOFT) in Figure A. Figure B presents an altitude clearance (ALTITUDE CLR), an ETIS report, and an ETIS update. No example of a visibility advisory (VIS) is shown.

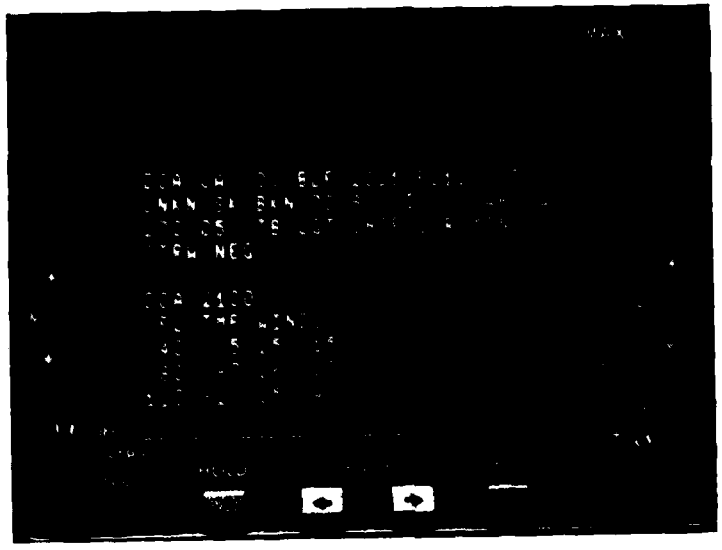


FIG. A.

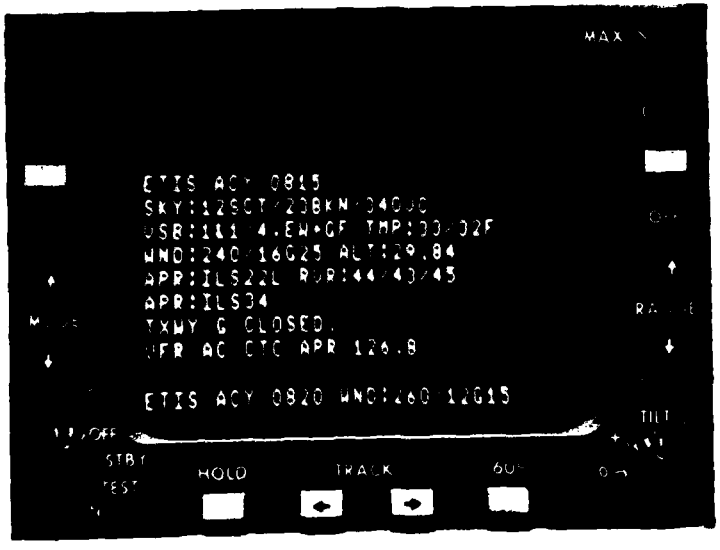


FIG. B.

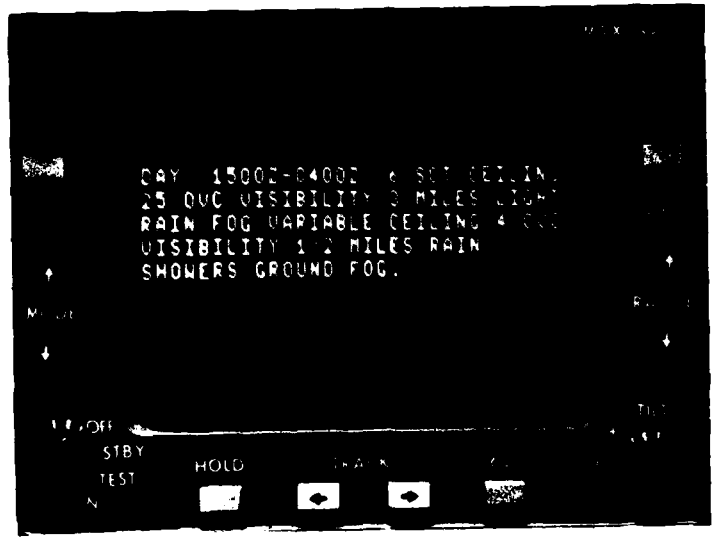
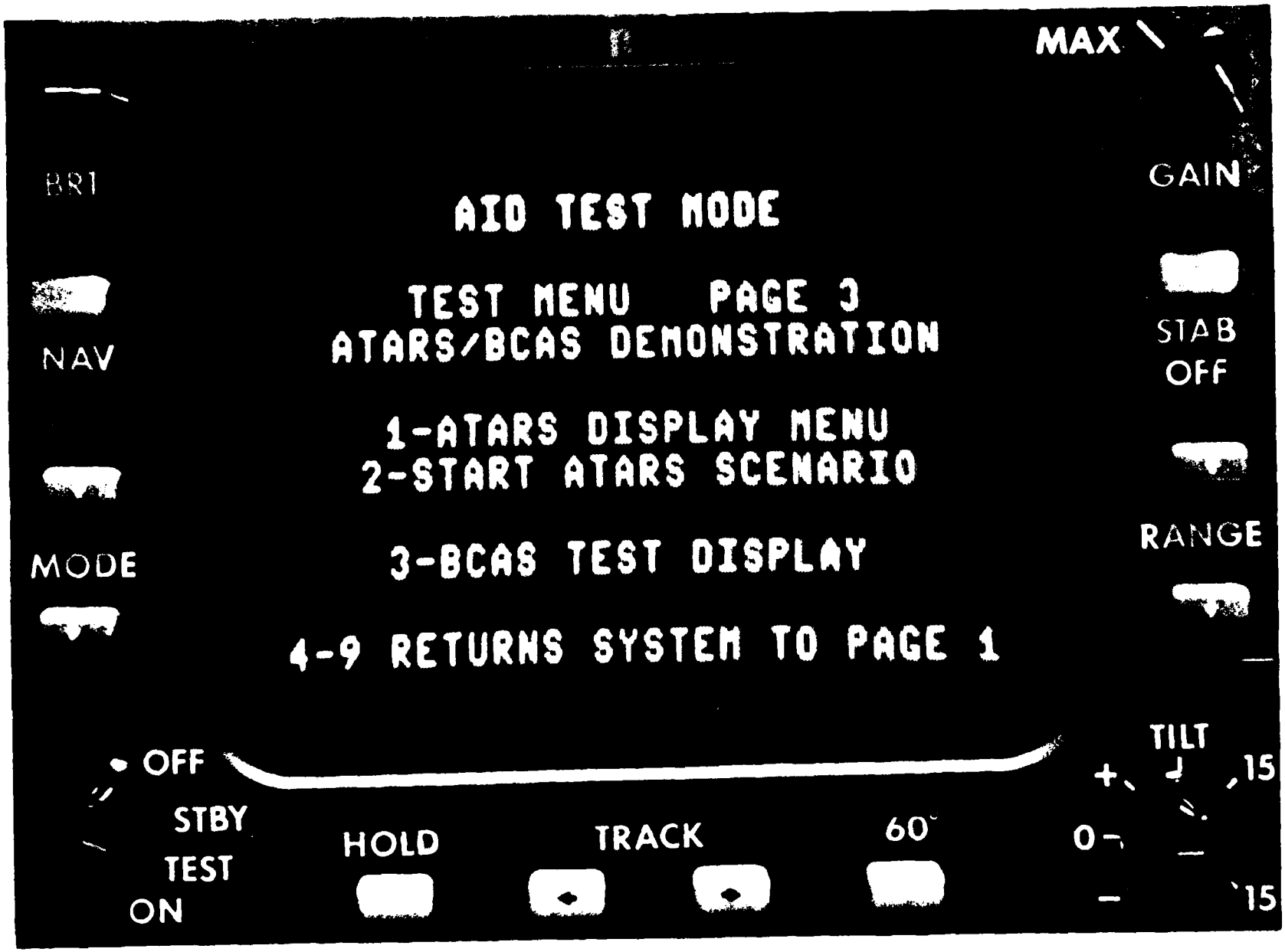


FIG. C.

AID TEST MODE - PAGE 3

PAGE 3 of the test menu (called from PAGE 2 by depressing "0" key) contains test scenarios for ATARS and BCAS. Various aspects of the ATARS demonstration can be controlled by first selecting the ATARS display menu to set the parameters desired. Once a scenario is initiated, it automatically runs to completion and cannot be stopped by entries from the keyboard.


MAX
BRT
GAIN
AID TEST MODE
TEST MENU PAGE 3
ATARS/BCAS DEMONSTRATION
NAV
STAB
OFF
1-ATARS DISPLAY MENU
2-START ATARS SCENARIO
MODE
RANGE
3-BCAS TEST DISPLAY
4-9 RETURNS SYSTEM TO PAGE 1
TILT
OFF
15
STBY
HOLD
TRACK
60°
0
TEST
ON
15

AID DATA LINK MODE

The AID data link mode is used during airborne operation to display actual messages which have been sent from the ground. Pilot requests for information are also shown on the display in this mode.

To initiate the AID data link, mode the mode select switch is turned to either the DATA LINK or the WX RADAR / DATA LINK position. The OFF/STBY/TEST/ON switch at the lower left-hand side of the display should be in the STBY or TEST position, and should never be turned to ON unless the aircraft is actually airborne. The DABS transponder should be turned on. Whenever the transponder is not being tracked by a DABS sensor, the words DABS CONTACT LOST will appear at the top of the CRT.

Pilot requests for information can be initiated when the AID is in this mode. A menu of available weather products is displayed as shown when the MENU key on the keyboard is pushed. The menu is treated as an uplink text message in terms of display priorities.

While formulating downlink requests in the data link mode, the user is guided through a series of steps by information which is presented on the display. This information is called a "prompting format". The prompting format for a weather request is retrieved by pushing the appropriate number key corresponding to the individual product number in the menu. When the operator is familiar with the various weather products, prompting formats can be retrieved by pushing the appropriate number key without going first to the menu. This feature cannot be used in the middle of a request, since the system will interpret the number as a data entry for the request.


ndi
MAX
GAIN
DABS CONTACT LOST
MENU
STAB
OFF
1-SURFACE OBS. 2-TERM. FORECAST
3-PILOT REPORTS 4-WINDS ALOFT
5-WX RADAR MAP 6-ETIS
7-HAZARDOUS WX 8-GENERAL ROST.
9-UNDEFINED 0-ATARS CONTROL
MODE
RANGE
SELECT PRODUCT BY NUMBER ENTRY
OFF
STBY
TEST
ON
HOLD
TRACK
60°
TILT
15
0
15

THE AID KEYBOARD

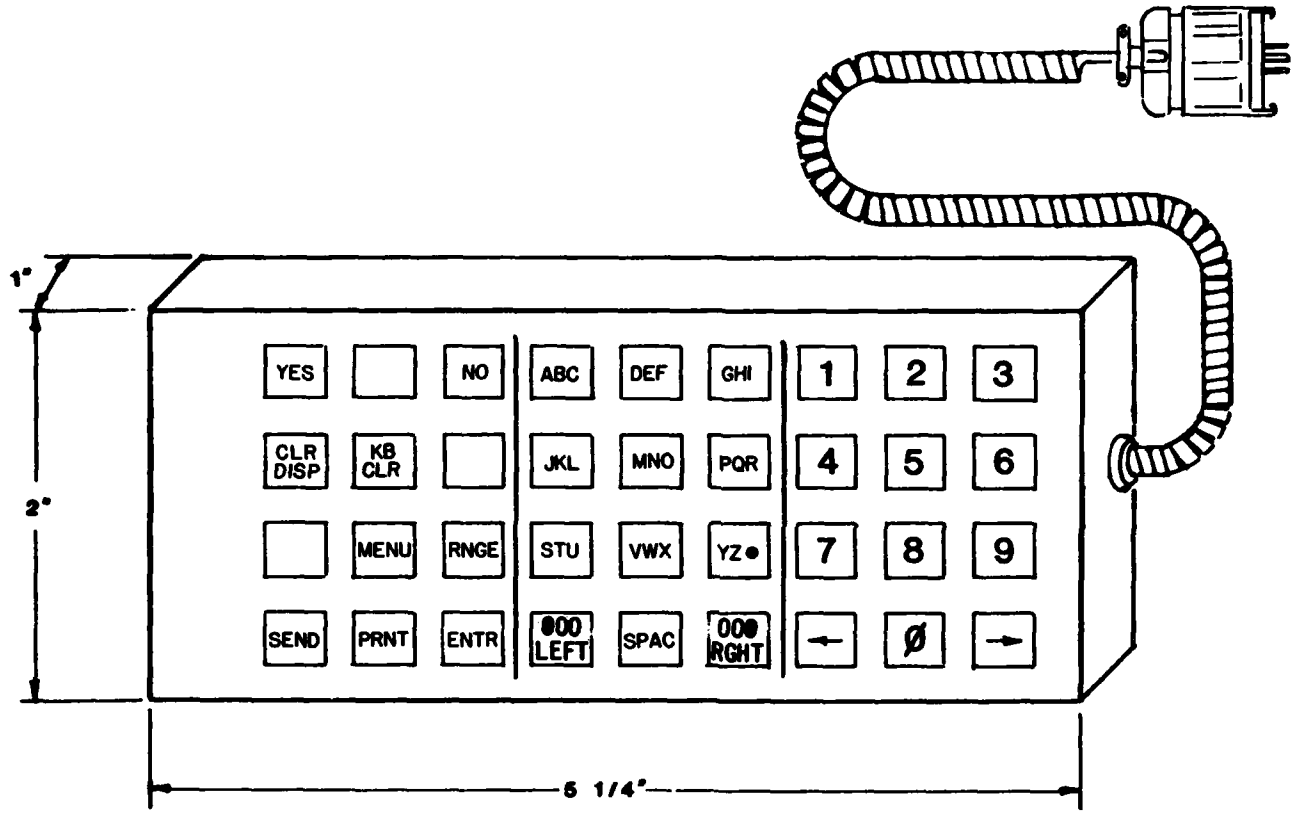
The AID keyboard, which is used to enter downlink requests, is shown in the figure. The keyboard is organized into three sections: control, alphabetic, and numeric.

The YES and NO buttons in the keyboard's control section are used for pilot acknowledgement of tactical messages. The NO button is separated by an unused button to prevent accidental entries. In the data link mode, CLR DISP clears the general display area while KB CLR clears all user keyboard entries. Use of the MENU and PRNT keys has been discussed. The RNGE key is used for ATARS range control. ENTR is used to enter data for individual requests into the AID, and SEND is used to initiate the transmission of the downlink request or group of requests.

Alphabetic entries are made from the middle portion of the keyboard. When an alphabetic key is pushed, the center character of the three characters on the key is displayed in the prompting message. The RGHT (right) and LEFT keys at the bottom of the alphabetic section can then be used to modify the displayed character. Repeated use of the RGHT and LEFT key can also be used to correct data entries. For example, if the DEF key is pushed, an "E" will appear on the display. If the RGHT key is then pushed twice, this "E" will first change to "F", and then to "G". A space (SPAC) key and a "period" character are also located on the alphabetic section.

Cursor controls (i.e., backspace and space-forward keys) are located on the numeric portion of the keyboard, and allow editing of the request entries. These controls are designated by arrows on the keys. Numeric entries are also made from this section of the keyboard.

KEYBOARD FOR THE AIRBORNE, INTELLIGENT DISPLAY



DATA LINK DISPLAY EXAMPLES

As an example of a pilot request in the data link mode, the prompting format for a digital weather radar map is shown in Figs. A, B, and C. This prompting format is used in order to obtain weather data from the ground.

Requested data is entered in the sequence indicated by a flashing cursor. The keyboard entries are displayed in yellow to differentiate them from the remainder of the request format, which is shown in blue.

To obtain the display state shown in Fig. A, the following sequence of operations can be used. First, enter the data link mode by properly setting the mode control and CRT switches as described earlier. Pushing the "5" button bypasses the menu and directly recalls the prompting format for the WX RADAR MAP, which is item #5 on the menu. The sequence of alphabetic keystrokes required to obtain the data entries shown is: ABC, MNO, RGHT, STU, LEFT, MNO, VWX. If this is the only downlink request, the SEND button should be pushed and the display will automatically be cleared in anticipation of the data arriving from the ground. If the operator desires to enter several requests of the same type, the ENTER button will move the current request to the right of the normal prompting field and the flashing cursor will return to the top of the prompting format as shown in Fig. B. In this example, up to four requests can be entered before the SEND button is pushed (Fig. C). If the operator desires to start over on a request, the KBD CLR key will clear all previous pilot entries for that request format and the flashing cursor will return to the top of the prompting format.

Valid keyboard entries to the prompting format are annunciated by a "beep" and incorrect entries are annunciated by a "buzz". For example if the operator attempts to enter a letter in the time field of a terminal forecast, the entry will be rejected and the annunciator will produce a "buzz".

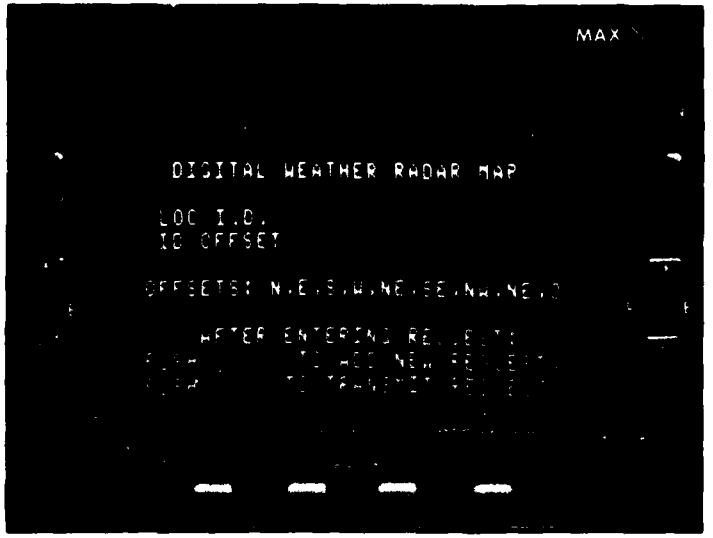


FIG. A.

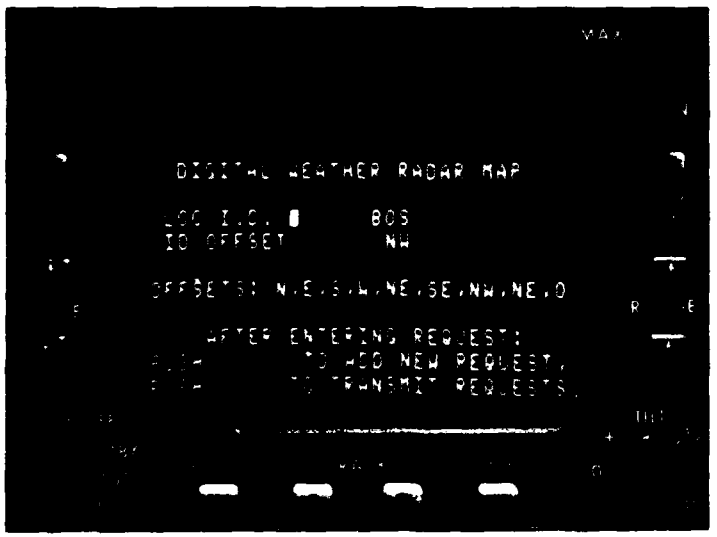


FIG. B.

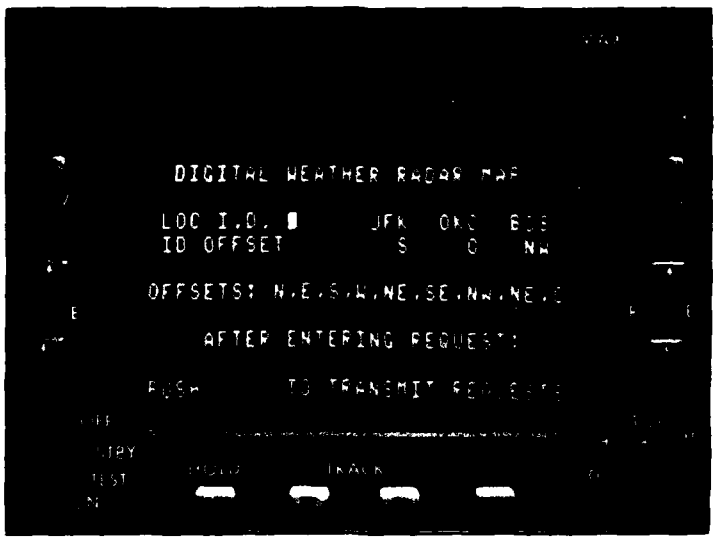
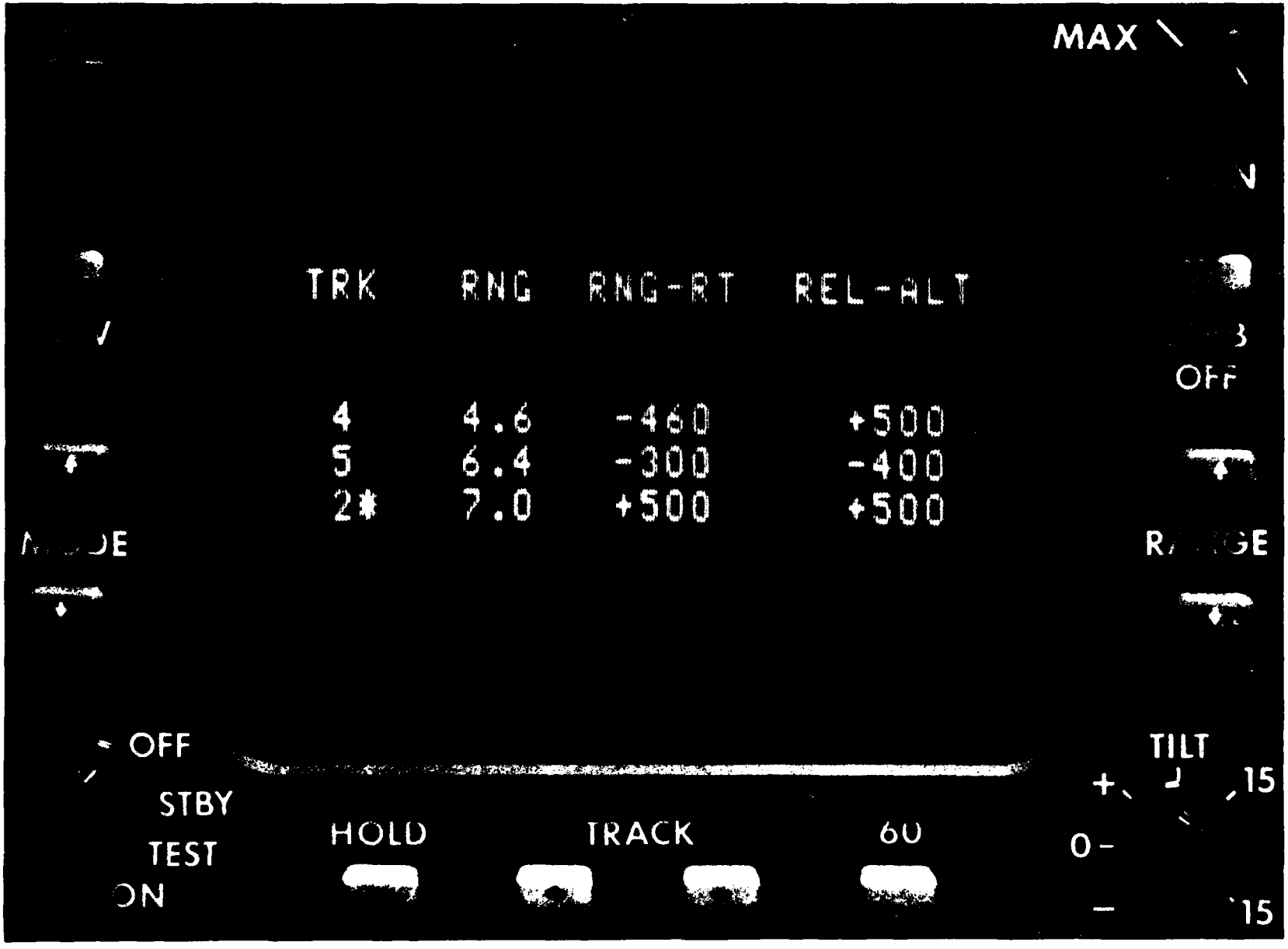


FIG. C.

BCAS DISPLAY

Since the AID contains a general purpose microcomputer, it is capable of performing various useful functions whether or not it is connected to DABS equipment. For example, the AID can be used to display information from a Beacon Collision Avoidance System (BCAS) Experimental Unit, as shown in the figure. The following information is displayed: track number (TRK), range (RNG) in nautical miles, range rate (RNG-RT) in knots, and relative altitude (REL-ALT) in feet. An asterisk on the display denotes a DABS-equipped aircraft. In this example, track 3 has triggered CAS logic, and is displayed in red. Other tracks are in blue. If a printout of this information is generated, all tracks shown in red will be denoted by the letter "C", for "command", preceeding the track number. When the display of actual BCAS data is desired, the mode select switch should be in either the DATA LINK or the WX RADAR / DATA LINK position. The BCAS data is displayed automatically when it is received by the AID. A BCAS test display is available on PAGE 3 of the AID test mode, as discussed earlier.


MAX
TRK RNG RNG-RT REL-ALT
4 4.6 -460 +500
5 6.4 -300 -400
2* 7.0 +500 +500
OFF
OFF
STBY
TEST
ON
HOLD
TRACK
60
TILT
+
15
0-
-
15